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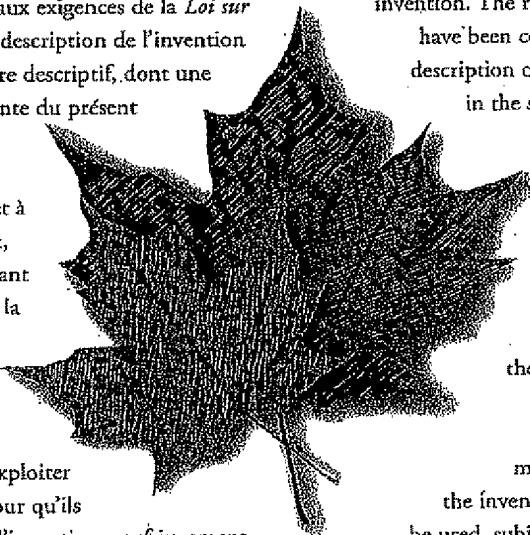
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Brevet canadien / Canadian Patent

* Le commissaire aux brevets a reçu une demande de délivrance de brevet visant une invention. Ladite requête satisfait aux exigences de la *Loi sur les brevets*. Le titre et la description de l'invention figurent dans le mémoire descriptif, dont une copie fait partie intégrante du présent document.

Le présent brevet confère à son titulaire et à ses représentants légaux, pour une période expirant vingt ans à compter de la date du dépôt de la demande au Canada, le droit, la faculté et le privilège exclusif de fabriquer, construire, exploiter et vendre à d'autres, pour qu'ils l'exploitent, l'objet de l'invention, sauf jugement en l'espèce rendu par un tribunal compétent, et sous réserve du paiement des taxes périodiques.



* The Commissioner of Patents has received a petition for the grant of a patent for an invention. The requirements of the *Patent Act* have been complied with. The title and a description of the invention are contained in the specification, a copy of which forms an integral part of this document.

The present patent grants to its owner and to the legal representatives of its owner, for a term which expires twenty years from the filing date of the application in Canada, the exclusive right, privilege and liberty of making, constructing and using the invention and selling it to others to be used, subject to adjudication before any court of competent jurisdiction, and subject to the payment of maintenance fees.

B R E V E T C A N A D I E N

2,490,464

C A N A D I A N P A T E N T

Date à laquelle le brevet a été
accordé et délivré

2008/09/02

Date on which the patent
was granted and issued

Date du dépôt de la demande

2002/06/25

Filing date of the application

Date à laquelle la demande est
devenue accessible au public
pour consultation

2003/12/31

Date on which the application
was made available for
public inspection

Commissaire aux brevets / Commissioner of Patents

Canada

3256 (CIP0 91) 06/07

OPIC  CIPO



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CA 2490464 C 2008/09/02

(11)(21) **2 490 464**

(12) **BREVET CANADIEN
CANADIAN PATENT**

(13) **C**

(86) Date de dépôt PCT/PCT Filing Date: 2002/06/25

(87) Date publication PCT/PCT Publication Date: 2003/12/31

(45) Date de délivrance/Issue Date: 2008/09/02

(85) Entrée phase nationale/National Entry: 2004/12/22

(86) N° demande PCT/PCT Application No.: EP 2002/007023

(87) N° publication PCT/PCT Publication No.: 2004/001100

(51) Cl.Int./Int.Cl. *C25D 5/18* (2006.01)

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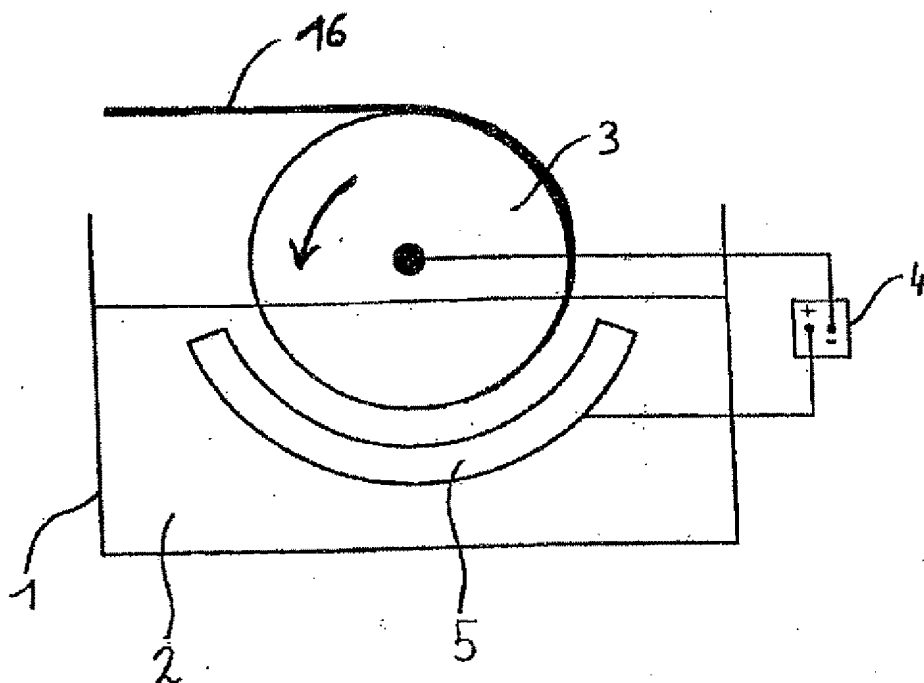
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(54) Titre : PROCÉDE DE PLACAGE ELECTROCHIMIQUE DE FEUILLES METALLIQUES ET DE COMPOSITES A MATRICE METALLIQUE, DE REVETEMENTS ET DE MICROCOMPOSANTS

(54) Title: PROCESS FOR ELECTROPLATING METALLIC AND METALL MATRIX COMPOSITE FOILS, COATINGS AND MICROCOMPONENTS



(57) Abrégé/Abstract:

The invention relates to a process for forming coatings or free-standing deposits of nano-crystalline metals, metal alloys or metal matrix composites. The process employs drum plating or selective plating processes involving pulse electrode-position and a non-stationary anode or cathode. Novel nano-crystalline metal matrix composites and micro components are disclosed as well. Also described is a process for forming micro-components with grain sizes below 1,000nm.

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CLAIMS

1. Process for cathodically electrodepositing a selected metallic material on a permanent or temporary substrate in nanocrystalline form with an average grain size of less than 100 nm at a deposition rate of at least 0.05 nm/h, comprising:

providing an aqueous electrolyte containing ions of said metallic material,

maintaining said electrolyte at a temperature in the range between 0 to 85°C,

agitating the electrolyte at an agitation rate in the range of 0.0001 to 10 litre per min and per cm² anode or cathode area or at an agitation rate in the range of 1 to 750 millilitre per mm and per Ampere,

providing an anode and a cathode in contact with said electrolyte, passing single or multiple D.C. cathodic-current pulses between said anode and said cathode, at intervals during which said current passes for a $t_{\text{cathodic-on}}$ -time period is in the range of 0.1 to 50 msec and does not pass for a $t_{\text{cathodic-off}}$ -time period is in the range of 0 to 500 msec, and passing single or multiple D.C. anodic-current pulses between said cathode and said anode at intervals during which said current passes for a $t_{\text{anodic-on}}$ -time period is in the range of 0 to 50 msec, a duty cycle being in a range of 5 to 100% and a cathodic charge (Q_{cathodic}) per interval being always larger than a anodic charge (Q_{anodic}).

2. Process according to claim 1, wherein the single or multiple D.C. cathodic-current pulses between said anode and said cathode have a peak current density in the range of 0.01 to 20 A/cm².
3. Process according to claim 2, wherein the peak current density of the cathodic-current pulses is in the range of 0.1 to 20 A/cm².
4. Process according to claim 3, wherein the peak current density of the cathodic-current pulses is in the range of 1 to 10 A/cm².
5. Process according to any one of claims 1 to 4, wherein said selected metallic material is (a) a pure metal selected from the group consisting of Ag, Au, Cu, Co, Cr, Ni, Fe, Pb, Pd, Pt, Rh, Ru, Sn, V, W, Zn, or (b) an alloy containing at least one of the elements of group (a) and alloying elements selected from the group consisting of C, P, S and Si.
6. Process according to any one of claims 1 to 5, wherein the duty cycle is in the range of 10 to 95 %.
7. Process according to claim 6, wherein the duty cycle is in the range of 20 to 80%.
8. Process according to any one of claims 1 to 7, wherein the deposition rate is at least 0.075 mm/h.
9. Process according to claim 8, wherein the deposition rate is at least 0.1 mm/h.

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29. Micro component having a maximum dimension of 1 mm produced by the electrodeposition process according to any one of claims 1 to 28, wherein the nanocrystalline metallic material has an average grain size less than 100 nm, the ratio between the maximum dimension and the average grain size being greater than 10.
30. Micro component according to claim 29, wherein the ratio between the maximum dimension of the micro component and the average grain size is greater than 100.
31. Micro component according to any one of claims 29 to 30, which has an equiaxed microstructure.